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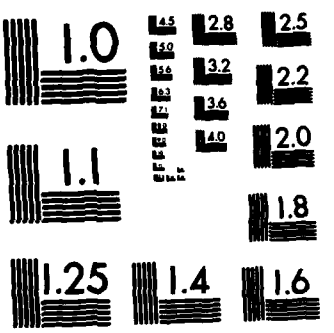

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# PROGRESS REPORT ON AFOSR GRANT 82-0305

# SEQUENTIAL DECISION MODELS IN RELIABILITY

FOR THE PERIOD

October 1, 1983 to September 30, 1984




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## I. INTRODUCTION AND SUMMARY.

Research during the period October 1, 1983 to September 30, 1984, was carried out in the areas of quality control, reliability in logistics support, and queueing theory applications to inventory. In addition, work from the previous year was completed in optimal inspection and optimal stockage policies for parts which replace failed components. The research was more varied than anticipated because Assistant Professor Subelman resigned unexpectedly to accept a position in industry and was replaced by Professor Jacobsen and Associate Professor Mortensen. UCLA is grateful to the Air Force Office of Scientific Research for permitting this substitution, and it resulted in a high quality and quantity of research for the grant. We will now outline this research.

## II. QUALITY CONTROL.

A main research topic was developing dynamic statistical quality control procedures to monitor production performance. The impetus for this research comes from the Quality Measurement Plan which was implemented in 1980 at Western Electric by its originator Bruce Hoadley. This research appeared in the Bell Systems Technical Journal. A second paper, "Quality Evaluation Plan Using Adaptive Kalman Filtering", by M.S. Phadke, also appeared in the Bell Systems Technical Journal. It represents a valuable modification of Hoadley's quality control procedure . However co-P.I. Mortensen shows that both its derivation and its testing by simulation are flawed in important ways. He than gives an alternative derivation. This research is described in Mortensen's paper entitled, Critique of "Quality Evaluation Plan Using Adaptive Kalman Filtering".

There are two Ph.D. students working in quality control under the guidance of P.I. Miller, and one has been advanced to candidacy. One of the dissertations follows the Hoadley formulation but considers alternative measures of quality. A simulation to compare the alternatives had been developed. The other dissertation generalizes the Kalman filter approach of Phadke so that distributions other than the normal can be used. The normal distribution is often not realistic in quality control. The results of Smith (1979) are used extensively for this generalization.

In addition P.I. Miller is completing a paper which derives properties of a random variable $Z_t$ where $Z_t$ satisfies $X_{t+1} = X_t + Z_t$ and $E(Z_t | X_t) = 0$. Here $X_t$ is the unknown quality of the production process in period t. The distributions of $X_{t+1}$ and $X_t$ are known, but are not normal. Conditions have been obtained for $Z_t$ to have a unimodel density function. This research is also related to that of Smith (1979).

## III. RELIABILITY IN LOGISTICS SUPPORT.

Co-P.I. Jacobsen has worked on the problem of how to stock spare parts so as to maximize the reliability of a system whose repair system has a network structure. The motivation for this study is the complex repair system for the space shuttle. This research was presented as an invited paper at the May, 1984, O.R.S.A. - T.I.M.S. meeting in San Francisco, and is entitled "Logistic Models For the Space Transportation-System". It is co-authored with Dr. Manuel Carillo. Work is continuing on a final version of this paper.

## IV. QUEUEING THEORY APPLICATIONS TO INVENTORY.

During this period Post-graduate Research Engineering Dr. Katy Azoury has co-authored a paper with Professor Percy Brill entitled, "An Application of the System-Point Method to Inventory Models Under Continuous Review" This paper has received an encouraging review by the Journal of Applied Probability and a revised version is being resubmitted. This research derived the stationary distribution of an inventory system using the system-point method of level crossing analysis. The system-point method of level crossing analysis is a new method which obtains stationary distributions for applied queueing systems in a much simple manner than previously possible.

## V. COMPLETION OF RESEARCH CARRIED OUT DURING THE PERIOD OCTOBER 1, 1982 TO SEPTEMBER 30, 1983.

Research in optimal inspection was completed and resulted in the paper "Optimal Search with Multiple Searches" by co-P.I. Subelman, dated March 1984. The search model is described in terms of searching for a lost object which in reliability applications represents a failed component. There is a know (prior) probability $p_i$ that the object is in location i. Searcher j, $1 \leq j \leq k$, is available for a total of $m_j$ searcher, and the cost of assigning him to location i is $c_{ij}$. If searcher j is assigned to location i and the lost object is in location i, the probability that the object will be found is $1 - B_{ij}$. In reliability applications $B_{ij}$ corresponds to the probabilitv that a malfunctioning component would pass inspection. The most important results are Proposition on page eight, which gives a condition which guarantees that a box will be searched in the difficult non-identical searcher case, and the Proposition and Corollary on page 12. Together they describe a situation where a myopic policy leads to minimizing the expected number of searches using non-identical searchers.

The research on the stockage of spare parts which replace failed components has been completed and the results constitute the paper of P.I. Miller entitled, "Scarf's State Reduction Method, Flexibility, and a Dependent Demand Inventory Model". The failure process (demands of spare parts) is described as an exponential smoothing process. Using a procedure first developed by Scarf for a Bayesian inventory model, we are able to formulate the model as one state variable dynamic program. This is justified by Theorem 1. The other major result of the paper is Theorem 2 which says that the model we have developed will order less stock than a comparable standard formulation which assumes that demands (failures) each period are independent. This paper has received an encouraging from Operations Research and a revised version was resubmitted in October, 1984.

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